CHAPTER 4

Temperature and Heat

the BIG idea

Heat is a flow of energy due to temperature differences.

Key Concepts

SECTION 4.1
Temperature depends on particle movement.
Learn how kinetic energy is the basis of temperature.

SECTION 4.2
Energy flows from warmer to cooler objects.
Learn about differences between temperature and heat, and how temperature changes in different substances.

SECTION 4.3
The transfer of energy as heat can be controlled.
Learn how energy is transferred through heat, and how that transfer can be controlled.

Internet Preview

CLASSZONE.COM

Chapter 4 online resources: Content Review, two Simulations, two Resource Centers, Math Tutorial, Test Practice

How does heat from the Sun increase this giraffe's temperature?

EXPLORE the BIG idea

Moving Colors

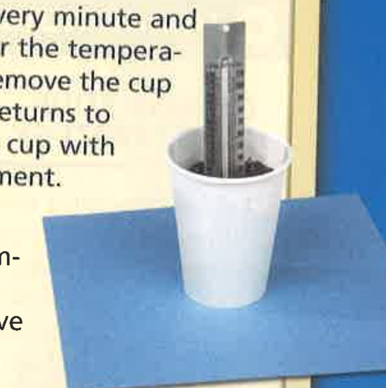
Fill a clear plastic cup halfway with cold water. Fill another cup halfway with hot water. Using an eyedropper, place a drop of food coloring at the very bottom of each cup. Observe.

Observe and Think What happened to the drop of food coloring in cold water? in hot water? Why might this have happened?

Does It Chill?

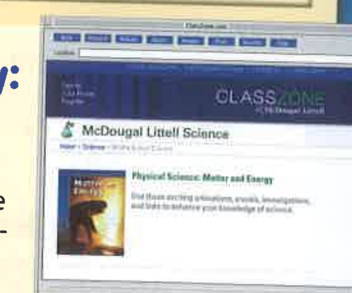
Place an outdoor thermometer in an empty paper cup, and place the cup in the freezer. Check the thermometer every minute and record the time it takes for the temperature to reach 0°C (32°F). Remove the cup from the freezer. After it returns to room temperature, fill the cup with soil and repeat the experiment.

Observe and Think How long did it take for the temperature to reach 0°C each time? Why might there have been a difference?



Internet Activity: Kinetic Theory

Go to **ClassZone.com** to explore how temperature affects the speed of particles. Examine the effects of particle size as well.



Observe and Think What is the relationship between temperature and kinetic energy? How does particle mass affect temperature?

NSTA scilinks.org SCILINKS

Kinetic Theory **Code: MDL064**

CHAPTER 4

Getting Ready to Learn

CONCEPT REVIEW

- Matter is made of particles too small to see.
- Matter can be solid, liquid, or gas.
- Energy is the ability to cause a change.
- There are different forms of energy.

VOCABULARY REVIEW

matter p. 9
energy p. 72
kinetic energy p. 74

CONTENT REVIEW
CLASSZONE.COM
Review concepts and vocabulary.

TAKING NOTES

CHOOSE YOUR OWN STRATEGY

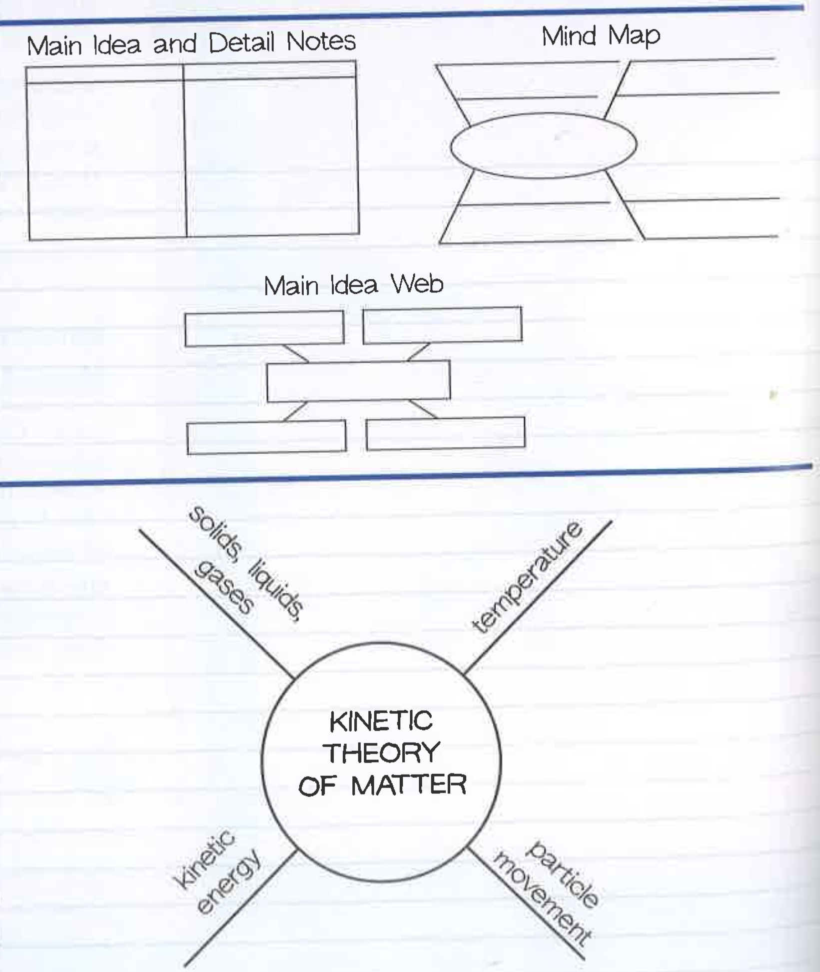
Take notes using one or more of the strategies from earlier chapters—**main idea and detail notes, main idea web,** or **mind map.** Feel free to mix and match the strategies, or use an entirely different note-taking strategy.

VOCABULARY STRATEGY

Place each vocabulary term at the center of a **description wheel** diagram. Write some words describing it on the spokes.

See the Note-Taking Handbook on pages R45–R51.

SCIENCE NOTEBOOK



KEY CONCEPT

4.1

Temperature depends on particle movement.

BEFORE, you learned

- All matter is made of particles
- Kinetic energy is the energy of motion
- Energy can be transferred or changed but is never created or destroyed

NOW, you will learn

- How temperature depends on kinetic energy
- How temperature is measured
- How changes in temperature can affect matter

VOCABULARY

kinetic theory of matter p. 104
temperature p. 105
degree p. 106
thermometer p. 107

EXPLORE Temperature

What can cause a change in temperature?

PROCEDURE

1. Work with a partner. Hold the rubber band with both hands. Without stretching it, hold it to the underside of your partner's wrist.
2. Move the rubber band away, then quickly stretch it once and keep it stretched. Hold it to the underside of your partner's wrist.
3. Move the rubber band away and quickly let it return to its normal size. Hold it to the underside of your partner's wrist.

WHAT DO YOU THINK?

- What effect did stretching the rubber band have on the temperature of the rubber band?
- What may have caused this change to occur?

MATERIALS
large rubber band

NOTE-TAKING STRATEGY
You could take notes on the movement of particles in matter by using a main idea web.

All matter is made of moving particles.

You have read that any object in motion has kinetic energy. All the moving objects you see around you—from cars to planes to butterflies—have kinetic energy. Even objects so small that you cannot see them, such as atoms, are in motion and have kinetic energy.

You might think that a large unmoving object, such as a house or a wooden chair, does not have any kinetic energy. However, all matter is made of atoms, and atoms are always in motion, even if the objects themselves do not change their position. The motion of these tiny particles gives the object energy. The chair you are sitting on has some amount of energy. You also have energy, even when you are not moving.

The Kinetic Theory of Matter

REMINDER
Kinetic energy is the energy of motion.

Physical properties and physical changes are the result of how particles of matter behave. The **kinetic theory of matter** states that all of the particles that make up matter are constantly in motion. As a result, all particles in matter have kinetic energy. The kinetic theory of matter helps explain the different states of matter—solid, liquid, and gas.

1. The particles in a solid, such as concrete, are not free to move around very much. They vibrate back and forth in the same position and are held tightly together by forces of attraction.
2. The particles in a liquid, such as water in a pool, move much more freely than particles in a solid. They are constantly sliding around and tumbling over each other as they move.
3. In a gas, such as the air around you or in a bubble in water, particles are far apart and move around at high speeds. Particles might collide with one another, but otherwise they do not interact much.

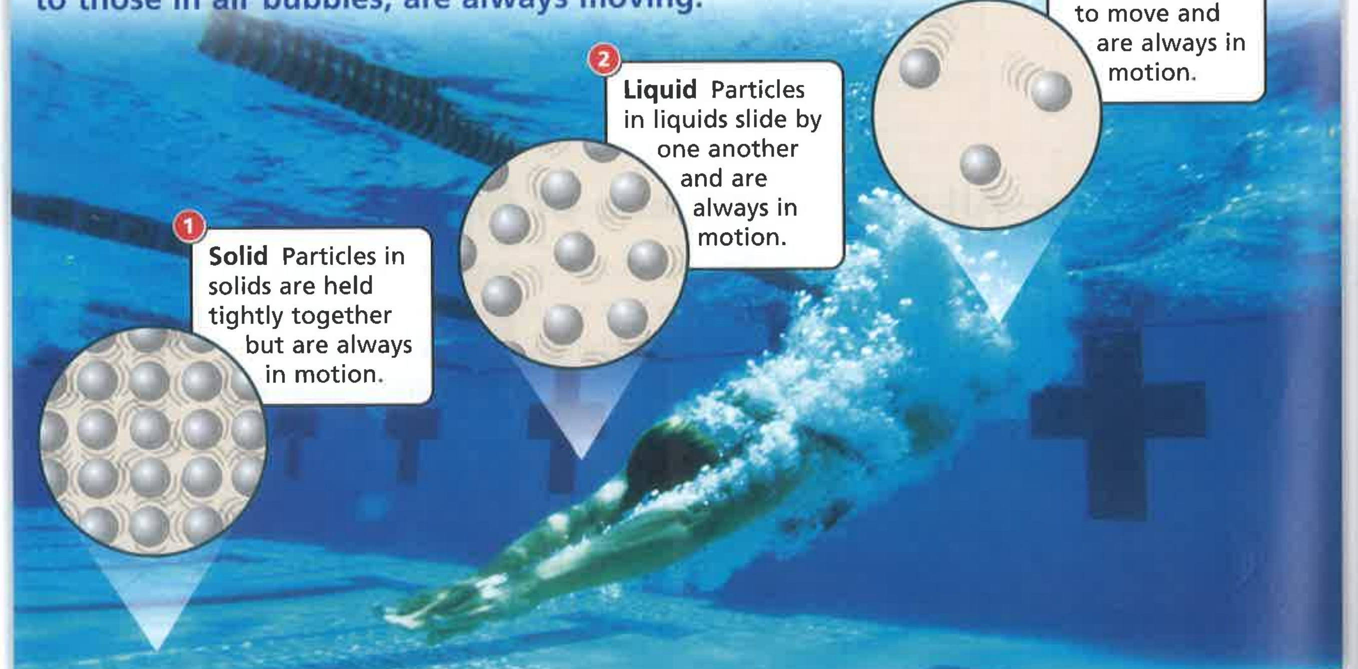
READING TIP
In illustrations of particle movement, more motion lines mean a greater speed.

Particles do not always move at the same speed. Within any group of particles, some are moving faster than others. A fast-moving particle might collide with another particle and lose some of its speed. A slow-moving particle might be struck by a faster one and start moving faster. Particles have a wide range of speeds and often change speeds.

CHECK YOUR READING What is the kinetic theory of matter?

Matter in Motion

All particles in this pool, from those in the concrete structure to those in air bubbles, are always moving.

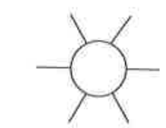


Temperature and Kinetic Energy

Particles of matter moving at different speeds have different kinetic energies because kinetic energy depends on speed. It is not possible to know the kinetic energy of each particle in an object. However, the average kinetic energy of all the particles in an object can be determined.

Temperature is a measure of the average kinetic energy of all the particles in an object. If a liquid, such as hot cocoa, has a high temperature, the particles in the liquid are moving very fast and have a high average kinetic energy. The cocoa feels hot. If a drink, such as a fruit smoothie, has a low temperature, the particles in the liquid are moving more slowly and have a lower average kinetic energy. The smoothie feels cold.

VOCABULARY
Remember to make a description wheel diagram for *temperature* and other vocabulary terms.



You experience the connection between temperature and the kinetic energy of particles every day. For example, to raise the temperature of your hands on a cold day—to warm your hands—you have to add energy, perhaps by putting your hands near a fire or a hot stove. The added energy makes the particles in your hands move faster. If you let a hot bowl sit on a table for a while, the particles in the bowl slow down due to collisions with particles in the air and in the table. The temperature of the bowl decreases, and it becomes cooler.

Temperature is the measurement of the average kinetic energy of particles, not just their speed. Recall that kinetic energy depends on mass as well as speed. Particles in a metal doorknob do not move as fast as particles in air. However, the particles in a doorknob have more mass and they can have the same amount of kinetic energy as particles in air. As a result, the doorknob and the air can have equal temperatures.

CHECK YOUR READING How does temperature change when kinetic energy increases?

Temperature can be measured.

RESOURCE CENTER
CLASSZONE.COM

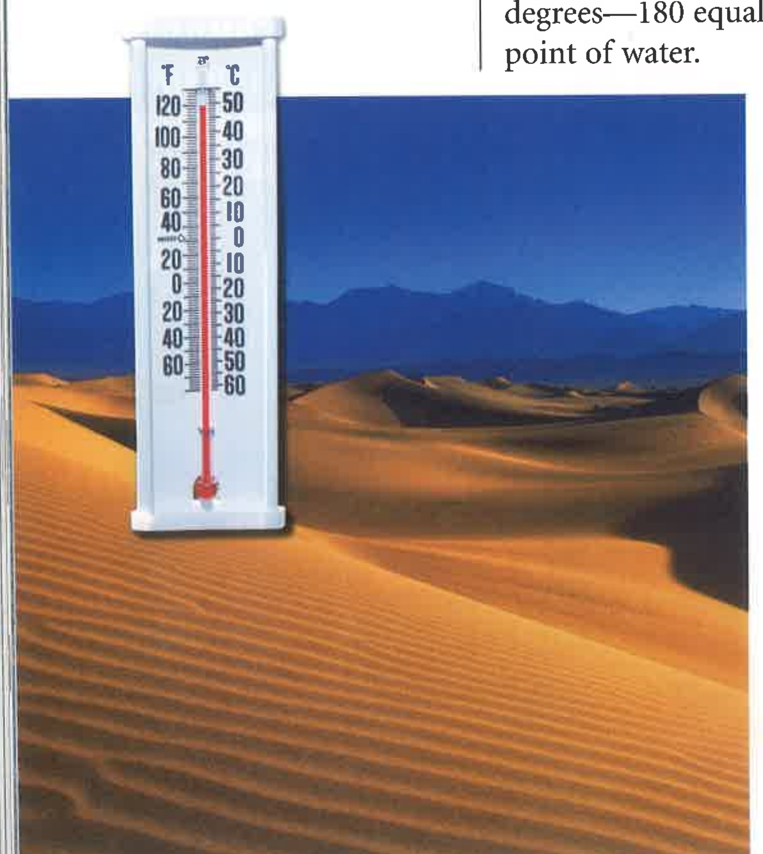
Find out more about temperature and temperature scales.

You have read that a warmer temperature means a greater average kinetic energy. How is temperature measured and what does that measurement mean? Suppose you hear on the radio that the temperature outside is 30 degrees. Do you need to wear a warm coat to spend the day outside? The answer depends on the temperature scale being used. There are two common temperature scales, both of which measure the average kinetic energy of particles. However, 30 degrees on one scale is quite different from 30 degrees on the other scale.

Temperature Scales

To establish a temperature scale, two known values and the number of units between the values are needed. The freezing and boiling points of pure water are often used as the standard values. These points are always the same under the same conditions and they are easy to reproduce. In the two common scales, temperature is measured in units called **degrees** (°), which are equally spaced units between two points.

The scale used most commonly in the United States for measuring temperature—in uses ranging from cooking directions to weather reports—is the Fahrenheit (FAR-uhn-HYT) scale (°F). It was developed in the early 1700s by Gabriel Fahrenheit. On the Fahrenheit scale, pure water freezes at 32°F and boils at 212°F. Thus, there are 180 degrees—180 equal units—between the freezing point and the boiling point of water.



During a summer day in Death Valley, California, the temperature can reach 49°C (120°F).

The temperature scale most commonly used in the rest of the world, and also used more often in science, is the Celsius (SEHL-see-uhs) scale (°C). This scale was developed in the 1740s by Anders Celsius. On the Celsius scale, pure water freezes at 0°C and boils at 100°C, so there are 100 degrees—100 equal units—between these two temperatures.

Recall the question asked in the first paragraph of this page. If the outside temperature is 30 degrees, do you need to wear a warm coat? If the temperature is 30°F, the answer is yes, because that temperature is colder than the freezing point of water. If the temperature is 30°C, the answer is no—it is a nice warm day (86°F).

CHECK YOUR READING How are the Fahrenheit and Celsius temperature scales different? How are they similar?

Thermometers

Temperature is measured by using a device called a thermometer. A **thermometer** measures temperature through the regular variation of some physical property of the material inside the thermometer. A mercury or alcohol thermometer, for example, can measure temperature because the liquid inside the thermometer always expands or contracts by a certain amount in response to a change in temperature.

Liquid-filled thermometers measure how much the liquid expands in a narrow tube as the temperature increases. The distances along the tube are marked so that the temperature can be read. At one time, thermometers were filled with liquid mercury because it expands or contracts evenly at both high and low temperatures. This means that mercury expands or contracts by the same amount in response to a given change in temperature. However, mercury is dangerous to handle, so many thermometers today are filled with alcohol instead.

Some thermometers work in a different way—they use a material whose electrical properties change when the temperature changes. These thermometers can be read by computers. Some show the temperature on a display panel and are often used in cars and in homes.

CHECK YOUR READING How do liquid-filled thermometers work?

INVESTIGATE Temperature Measurements

How does a thermometer work?

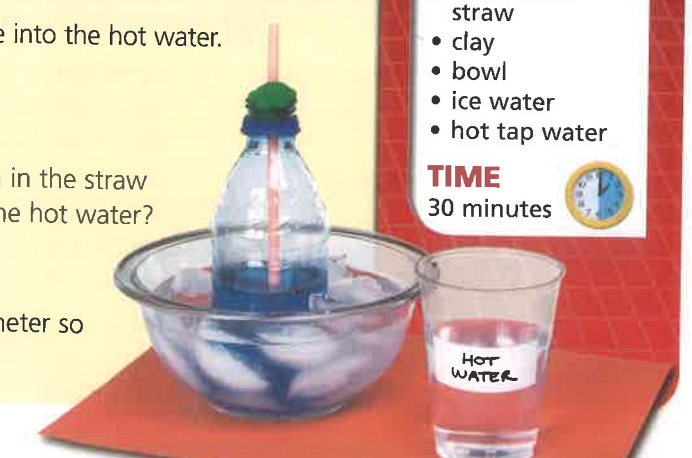
PROCEDURE

1. To make your own thermometer, fill the bottle halfway with the alcohol solution. Add a small amount of food coloring and mix thoroughly.
2. Place the straw into the bottle. Use clay to suspend the straw above the bottom of the bottle and to seal the bottle's mouth completely.
3. Pour ice water into the bowl and place the bottle into the ice water. Record your observations, and then empty the bowl.
4. Pour hot water into the bowl and place the bottle into the hot water. Record your observations.

WHAT DO YOU THINK?

- What happened to the level of the alcohol solution in the straw when the bottle was put into the ice water? into the hot water?
- Why do you think these changes happened?

CHALLENGE How could you modify your thermometer so that you could use it to measure a temperature?



SKILL FOCUS
Modeling

MATERIALS
- plastic bottle
- alcohol solution
- food coloring
- clear plastic straw
- clay
- bowl
- ice water
- hot tap water

TIME
30 minutes

During construction of the Gateway Arch in St. Louis, engineers had to account for thermal expansion.

Thermal Expansion

The property that makes liquid-filled thermometers work is called thermal expansion. Thermal expansion affects many substances, not just alcohol and liquid mercury. All gases, many liquids, and most solids expand when their temperature increases.

Construction engineers often have to take thermal expansion into account because steel and concrete both expand with increasing temperature. An interesting example involves the construction of the Gateway Arch in St. Louis, which is built mostly of steel.

The final piece of the Arch to be put into place was the top segment joining the two legs. The Arch was scheduled to be completed in the middle of the day for its opening ceremony. However, engineers knew that the side of the Arch facing the Sun would get hot and expand due to thermal expansion.

This expansion would narrow the gap between the legs and prevent the last piece from fitting into place. In order to complete the Arch, workers sprayed water on the side facing the Sun. The water helped cool the Arch and decreased the amount of thermal expansion. Once the final segment was in place, engineers made the connection strong enough to withstand the force of the expanding material.

Thermal expansion occurs in solids because the particles of solids vibrate more at higher temperatures. Solids expand as the particles move ever so slightly farther apart. This is why bridges and highways are built in short segments with slight breaks in them, called expansion joints. These joints allow the material to expand safely.

CHECK YOUR READING Why do objects expand when their temperatures increase?

4.1 Review

KEY CONCEPTS

1. Describe the relationship between temperature and kinetic energy.
2. Describe the way in which thermometers measure temperature.
3. How can you explain thermal expansion in terms of kinetic energy?

CRITICAL THINKING

4. **Synthesize** Suppose a mercury thermometer shows that the air temperature is 22°C (72°F). Do particles in the air have more average kinetic energy than particles in the mercury? Explain.
5. **Infer** If a puddle of water is frozen, do particles in the ice have kinetic energy? Explain.

CHALLENGE

6. **Apply** Why might a sidewalk be built with periodic breaks in it?

MATH in SCIENCE

SKILL: METRIC CONVERSIONS

How Hot Is Hot?

MATH TUTORIAL
CLASSZONE.COM
Click on Math Tutorial for more help with temperature conversions.

Temperatures on Earth can vary greatly, from extremely hot in some deserts to frigid in polar regions. The meaning of a temperature measurement depends on which temperature scale is being used. A very high temperature on the Fahrenheit scale is equal to a much lower temperature on the Celsius scale. The table shows the formulas used to convert temperatures between the two scales.

Conversion	Formula
Fahrenheit to Celsius	$°C = \frac{5}{9}(°F - 32)$
Celsius to Fahrenheit	$°F = \frac{9}{5}°C + 32$

Example

The boiling point of pure water is 212°F. Convert that temperature to a measurement on the Celsius scale.

(1) Use the correct conversion formula.

$$°C = \frac{5}{9}(°F - 32)$$

(2) Substitute the temperature given for the correct variable in the formula.

$$°C = \frac{5}{9}(212 - 32) = \frac{5}{9} \cdot 180 = 100$$

ANSWER °C = 100

Use the information in the table below to answer the questions that follow.

Highest and Lowest Temperatures Recorded on Earth

Location	Highest Temp. (°F)	Location	Lowest Temp. (°F)
El Azizia, Libya	136	Vostok, Antarctica	–129
Death Valley, California	134	Oimekon, Russia	–90
Tirat Tsvi, Israel	129	Verkhoyansk, Russia	–90
Cloncurry, Australia	128	Northice, Greenland	–87
Seville, Spain	122	Snag, Yukon, Canada	–81

1. What is the highest temperature in °C?
2. What is the temperature difference in °C between the highest and second highest temperatures?
3. What is the difference between the highest and lowest temperatures in °F? in °C?

CHALLENGE The surface of the Sun is approximately 5500°C. What is this temperature in °F?

Temperatures on Earth, ranging from the extremes of frigid polar regions to the hottest deserts, can differ by more than 250°F.

KEY CONCEPT

4.2 Energy flows from warmer to cooler objects.

BEFORE, you learned
- All matter is made of moving particles
- Temperature is the measurement of average kinetic energy of particles in an object
- Temperature can be measured

NOW, you will learn
- How heat is different from temperature
- How heat is measured
- Why some substances change temperature more easily than others

VOCABULARY
heat p. 110
thermal energy p. 111
calorie p. 112
joule p. 112
specific heat p. 113

THINK ABOUT

Why does water warm up so slowly?

If you have ever seen food being fried in oil or butter, you know that the metal frying pan heats up very quickly, as does the oil or butter used to coat the pan's surface. However, if you put the same amount of water as you put oil in the same pan, the water warms up more slowly. Why does water behave so differently from the metal, oil, or butter?

NOTE-TAKING STRATEGY
The mind map organizer would be a good choice for taking notes on heat.

Heat is different from temperature.

Heat and temperature are very closely related. As a result, people often confuse the concepts of heat and temperature. However, they are not the same. Temperature is a measurement of the average kinetic energy of particles in an object. **Heat** is a flow of energy from an object at a higher temperature to an object at a lower temperature.

If you add energy as heat to a pot of water, the water's temperature starts to increase. The added energy increases the average kinetic energy of the water molecules. Once the water starts to boil, however, adding energy no longer changes the temperature of the water. Instead, the heat goes into changing the physical state of the water from liquid to gas rather than increasing the kinetic energy of the water molecules. This fact is one demonstration that heat and temperature are not the same thing.

CHECK YOUR READING What is heat?

Heat and Thermal Energy

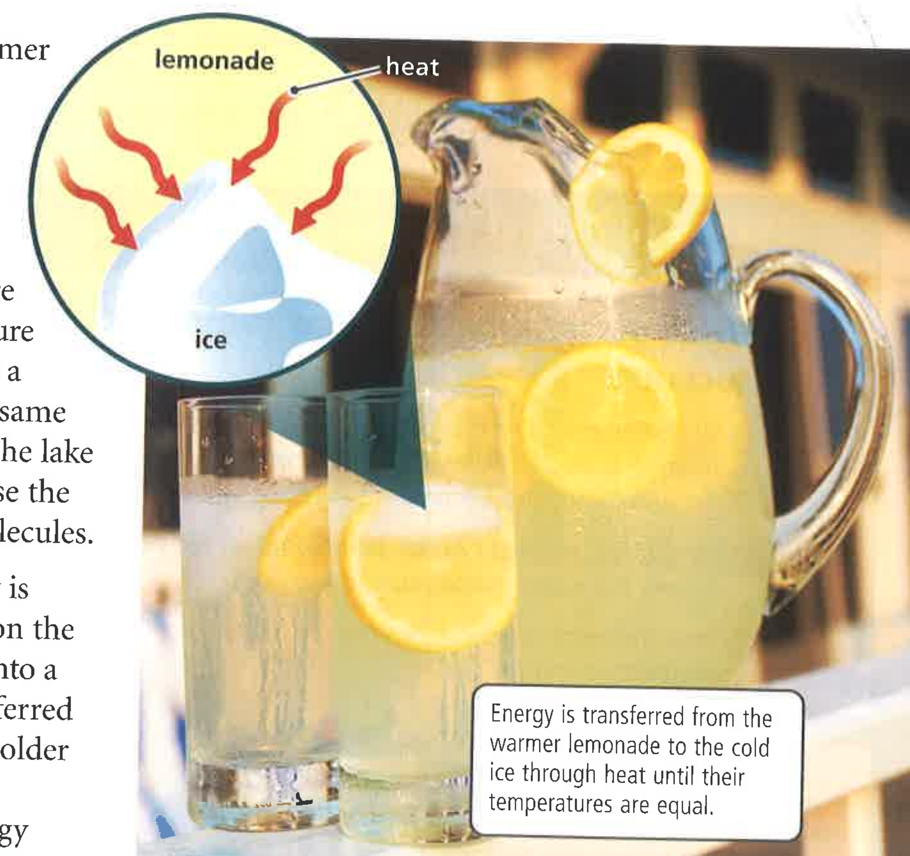
RESOURCE CENTER
CLASSZONE.COM
Learn more about thermal energy.

Suppose you place an ice cube in a bowl on a table. At first, the bowl and the ice cube have different temperatures. However, the ice cube melts, and the water that comes from the ice will eventually have the same temperature as the bowl. This temperature will be lower than the original temperature of the bowl but higher than the original temperature of the ice cube. The water and the bowl end up at the same temperature because the particles in the ice cube and the particles in the bowl continually bump into each other and energy is transferred from the bowl to the ice.

Heat is always the transfer of energy from an object at a higher temperature to an object at a lower temperature. So energy flows from the particles in the warmer bowl to the particles in the cold ice and, later, the cooler water. If energy flowed in the opposite direction—from cooler to warmer—the ice would get colder and the bowl would get hotter, and you know that never happens.

CHECK YOUR READING In which direction does heat always transfer energy?

When energy flows from a warmer object to a cooler object, the thermal energy of both of the objects changes. **Thermal energy** is the total random kinetic energy of particles in an object. Note that temperature and thermal energy are different from each other. Temperature is an average and thermal energy is a total. A glass of water can have the same temperature as Lake Superior, but the lake has far more thermal energy because the lake contains many more water molecules.

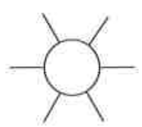


Energy is transferred from the warmer lemonade to the cold ice through heat until their temperatures are equal.

Another example of how energy is transferred through heat is shown on the right. Soon after you put ice cubes into a pitcher of lemonade, energy is transferred from the warmer lemonade to the colder ice. The lemonade's thermal energy decreases and the ice's thermal energy increases. Because the particles in the lemonade have transferred some of their energy to the particles in the ice, the average kinetic energy of the particles in the lemonade decreases. As a result, the temperature of the lemonade decreases.

CHECK YOUR READING How are heat and thermal energy related to each other?

VOCABULARY
Remember to make description wheel diagrams for *calorie, joule,* and other vocabulary terms.



Measuring Heat

The most common units of heat measurement are the calorie and the joule (jool). One **calorie** is the amount of energy needed to raise the temperature of 1 gram of water by 1°C. The **joule** (J) is the standard scientific unit in which energy is measured. One calorie is equal to 4.18 joules.

You probably think of calories in terms of food. However, in nutrition, one Calorie—written with a capital C—is actually one kilocalorie, or 1000 calories. This means that one Calorie in food contains enough energy to raise the temperature of 1 kilogram of water by 1°C. So, each Calorie in food contains 1000 calories of energy.

How do we know how many Calories are in a food, such as a piece of chocolate cake? The cake is burned inside an instrument called a calorimeter. The amount of energy released from the cake through heat is the number of Calories transferred from the cake to the calorimeter. The energy transferred to the calorimeter is equal to the amount of energy originally in the cake. A thermometer inside the calorimeter measures the increase in temperature from the burning cake, which is used to calculate how much energy is released.

CHECK YOUR READING How is heat measured?

INVESTIGATE Heat Transfer

Which substances change temperature faster?

PROCEDURE

1. Using the graduated cylinder and the balance, separately measure 20 g of room-temperature water, 20 g of pennies, and 20 g of aluminum foil. Pour the water into a beaker until it is needed.
2. Using the graduated cylinder, pour 50 mL of hot water into each of the cups. Record the water temperature in each cup.
3. Pour the room-temperature water into one cup. Place the pennies in the second cup and the foil in the third. After 5 minutes, record the temperature of the water in each of the cups.

WHAT DO YOU THINK?

- How did the temperature changes in the three cups compare?
- What might account for the differences you observed?

CHALLENGE Why might items such as pots and pans be made of materials like copper, stainless steel, or iron?

SKILL FOCUS
Measuring

MATERIALS
- graduated cylinder
- balance
- room-temperature water
- pennies
- aluminum foil
- hot tap water
- 100 mL beaker
- 3 plastic cups
- thermometer
- stopwatch

TIME
30 minutes

Some substances change temperature more easily than others.

Have you ever seen an apple pie taken right out of the oven? If you put a piece of pie on a plate to cool, you can touch the pie crust in a few minutes and it will feel only slightly warm. But if you try to take a bite, the hot pie filling will burn your mouth. The pie crust cools much more quickly than the filling, which is mostly water.

Specific Heat

The amount of energy required to raise the temperature of 1 gram of a substance by 1°C is the **specific heat** of that substance. Every substance has its own specific heat value. So, each substance absorbs a different amount of energy in order to show the same increase in temperature.

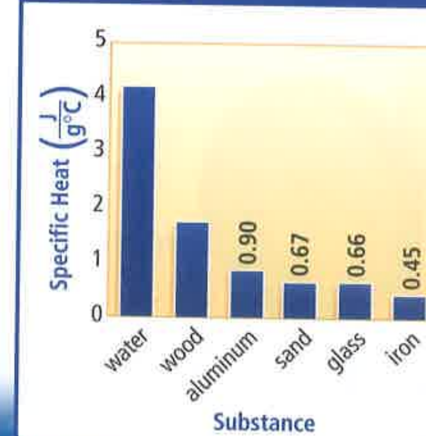
If you look back at the definition of a calorie, you will see that it is defined in terms of water—one calorie raises the temperature of 1 gram of water by 1°C. So, water has a specific heat of exactly 1.00 calorie per gram per °C. Because one calorie is equal to 4.18 J, it takes 4.18 J to raise the temperature of one gram of water by 1°C. In joules, water's specific heat is 4.18 J per gram per °C. If you look at the specific heat graph shown below, you will see that 4.18 is an unusually large value. For example, one gram of iron has to absorb only 0.45 joules for its temperature to increase by 1°C.

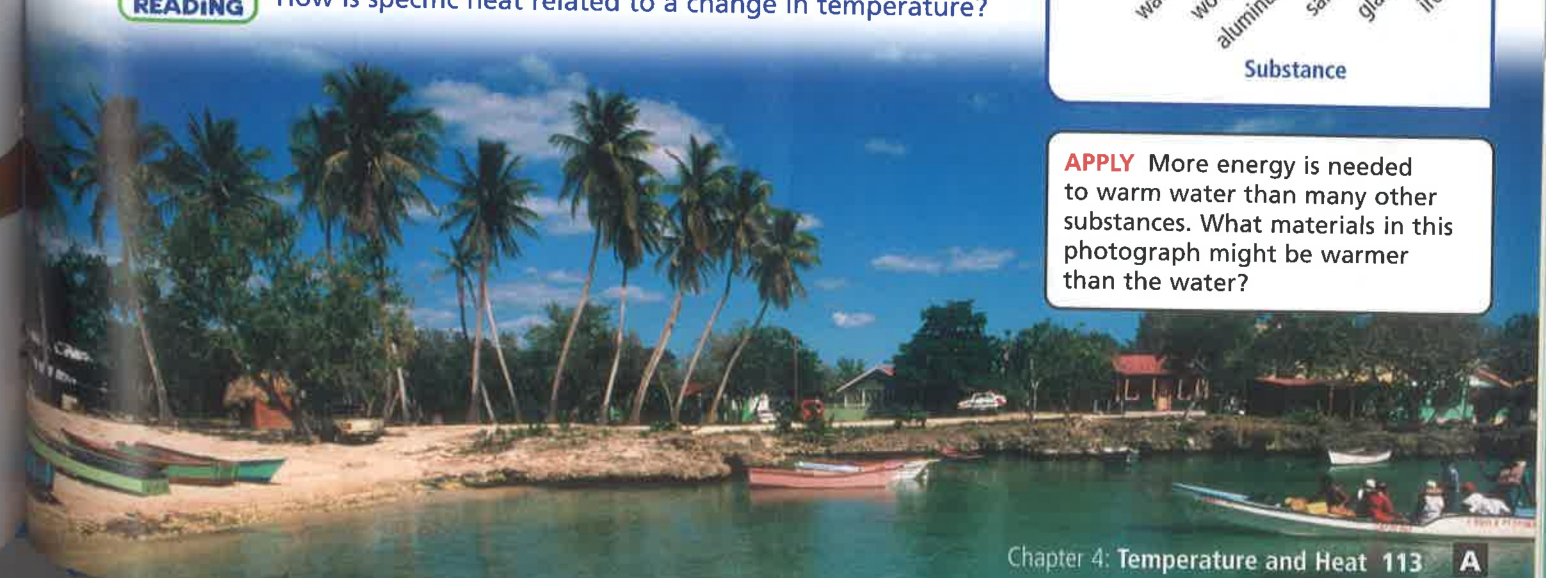
READING TIP Joules per gram per °C is shown as $\frac{J}{g°C}$.

A substance with a high specific heat value, like water, not only has to absorb a large quantity of energy for its temperature to increase, but it also must release a large quantity of energy for its temperature to decrease. This is why the apple pie filling can still be hot while the pie crust is cool. The liquid filling takes longer to cool. The high specific heat of water is also one reason it is used as a coolant in car radiators. The water can absorb a great deal of energy and protect the engine from getting too hot.

CHECK YOUR READING How is specific heat related to a change in temperature?

Specific Heat of Substances





APPLY More energy is needed to warm water than many other substances. What materials in this photograph might be warmer than the water?

Specific Heat and Mass

Recall that thermal energy is the total kinetic energy of all particles in an object. So, thermal energy depends on the object's mass. Suppose you have a cup of water at a temperature of 90°C (194°F) and a bathtub full of water at a temperature of 40°C (104°F). Which mass of water has more thermal energy? There are many more water molecules in the bathtub, so the water in the tub has more thermal energy.

Specific Heat, Mass, and Weather

The temperature of a large body of water influences the temperature of nearby land. The green shading shows how far this effect extends.

The water in the cup has the same specific heat as the water in the tub. However, the cup of water will cool more quickly than the water in the bathtub. The tub of water has to release more thermal energy to its surroundings, through heat, to show a decrease in temperature because it has so much more mass.

This idea is particularly relevant to very large masses. For example, Lake Michigan holds 4.92 quadrillion liters (1.30 quadrillion gallons) of water. Because of the high specific heat of water and the mass of water in the lake, the temperature of Lake Michigan changes very slowly.

The temperature of the lake affects the temperatures on its shores. During spring and early summer, the lake warms slowly, which helps keep the nearby land cooler. During the winter, the lake cools slowly, which helps keep the nearby land warmer. Temperatures within about 15 miles of the lake can differ by as much as 6°C (about 10°F) from areas farther away from the lake.

As you will read in the next section, the way in which a large body of water can influence temperatures on land depends on how energy is transferred through heat.

CHECK YOUR READING How does an object's thermal energy depend on its mass?

4.2 Review

KEY CONCEPTS

1. How is temperature related to heat?
2. How do the units that are used to measure heat differ from the units that are used to measure temperature?
3. Describe specific heat in your own words.

CRITICAL THINKING

4. **Compare and Contrast** How are a calorie and a joule similar? How are they different?
5. **Synthesize** Describe the relationships among kinetic energy, temperature, heat, and thermal energy.

CHALLENGE

6. **Infer** Suppose you are spending a hot summer day by a pool. Why might the water in the pool cool the air near the pool?

SCIENCE on the JOB

CHEF

Cooking with Heat

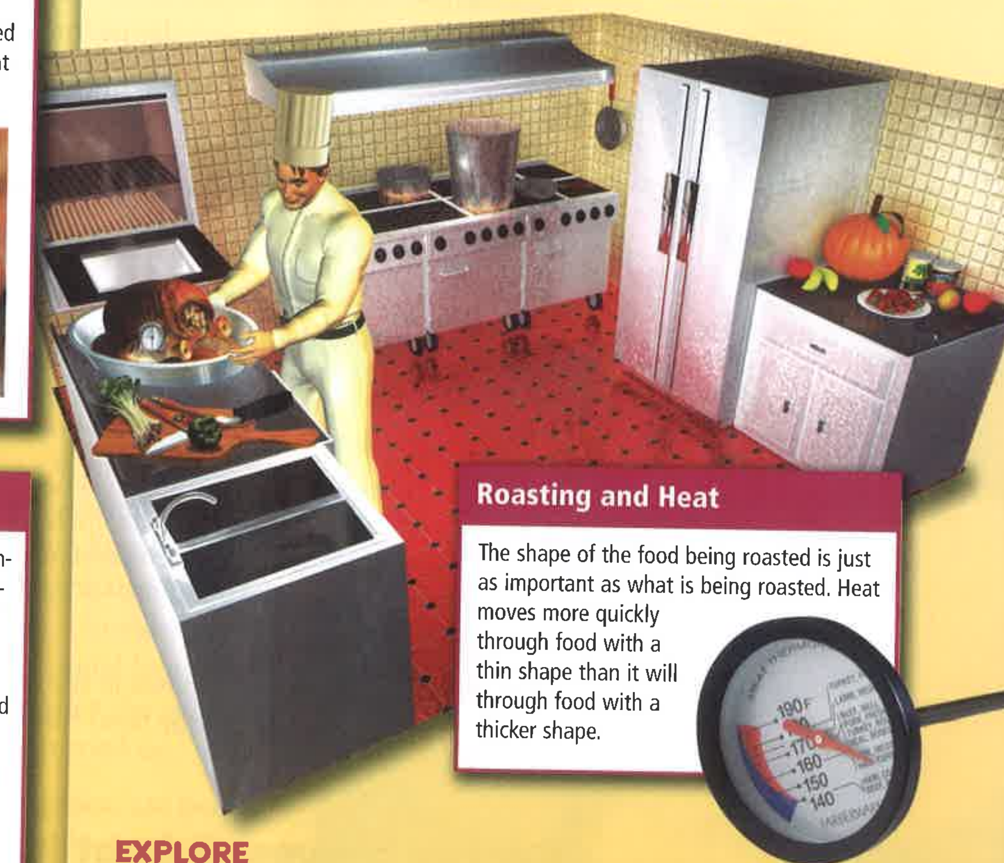
A chef makes many decisions about cooking a meal based on heat and temperature. The appropriate temperature and cooking method must be used. A chef must calculate the cooking time of each part of the meal so that everything is finished at the same time. A chef also needs to understand how heat moves through food. For example, if an oven temperature is too hot, meat can be overcooked on the outside and undercooked on the inside.

Bread vs. Meat

Chefs have to understand how energy as heat is transferred to different foods. For example, the fluffy texture of bread comes from pockets of gas that separate its fibers. The gas is a poor conductor of energy. Therefore, more energy and a longer cooking time are needed to cook bread than to cook an equal amount of meat.

What Temperature?

Eggs cook very differently under different temperatures. For example, temperature is important when baking meringue, which is made of egg whites and sugar. A Key lime pie topped with meringue is baked at 400°F to make a meringue that is soft. However, meringue baked at 275°F makes light and crisp dessert shells.



Roasting and Heat

The shape of the food being roasted is just as important as what is being roasted. Heat moves more quickly through food with a thin shape than it will through food with a thicker shape.

EXPLORE

1. **COMPARE** Using a cookbook, find the oven temperatures for baking biscuits, potatoes, and beef. Could you successfully cook a roast and biscuits in the oven at the same time?
2. **CHALLENGE** Crack open three eggs. Lightly beat one egg in each of three separate bowls. Follow the steps below.
   1. Heat about two cups of water to 75°C in a small pan.
   2. Pour one of the eggs into the water in the pan.
   3. Observe the egg and record your observations.
   4. Repeat steps 1–3 twice, once with boiling water and then with room-temperature water.

   Describe the differences that you observed among the three eggs. What may account for these differences?